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(56) Documents cited
GB 2226126 A GB 2203824 A GB 2164135 A
GB 1232432 A GB 0808412 A US 4596284 A

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(54) Ventilation with heating and heat exchange

(57) An electrically operated heating or cooling unit with forced ventilation incorporating waste heat recovery consisting of a drum type rotary regenerative heat exchanger 1 with a multi layer wound wire gauze matrix two axial flow fans 4, 8 driven by integrated DC motors 12, 13, these fans being parallel to the axis of the drum and an electric heater/cooler device 9 at the outlet of the fresh air fan 8 as well as a duct and valve 10 linking the outlet of the stale air fan with that of the heater/cooler. The heating unit 9 may be a ceramic foam resistance unit providing a high surface/volume ratio. The unit may serve several rooms, each having an augmenting unit with an auxiliary fan (37, fig 6) as well as heater/cooler (9) together with a valve system (32) which permits adjustment to the demands of a particular room as well as operation when the central appliance is shut off.

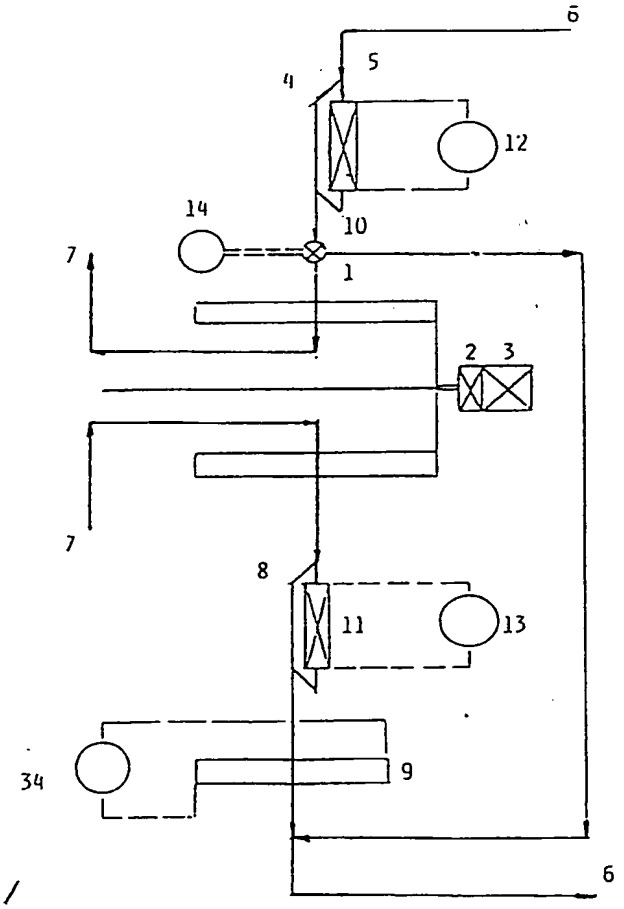


FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 251 301 A

FIG. 1.

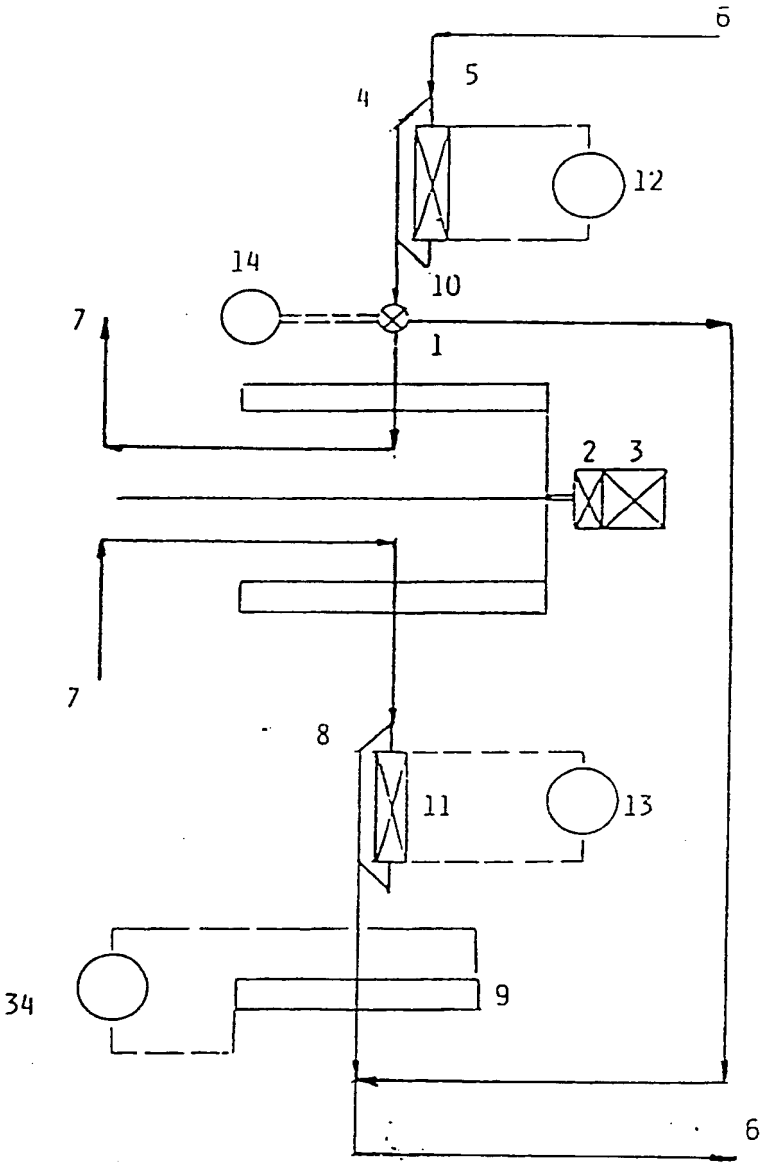


FIG. 2

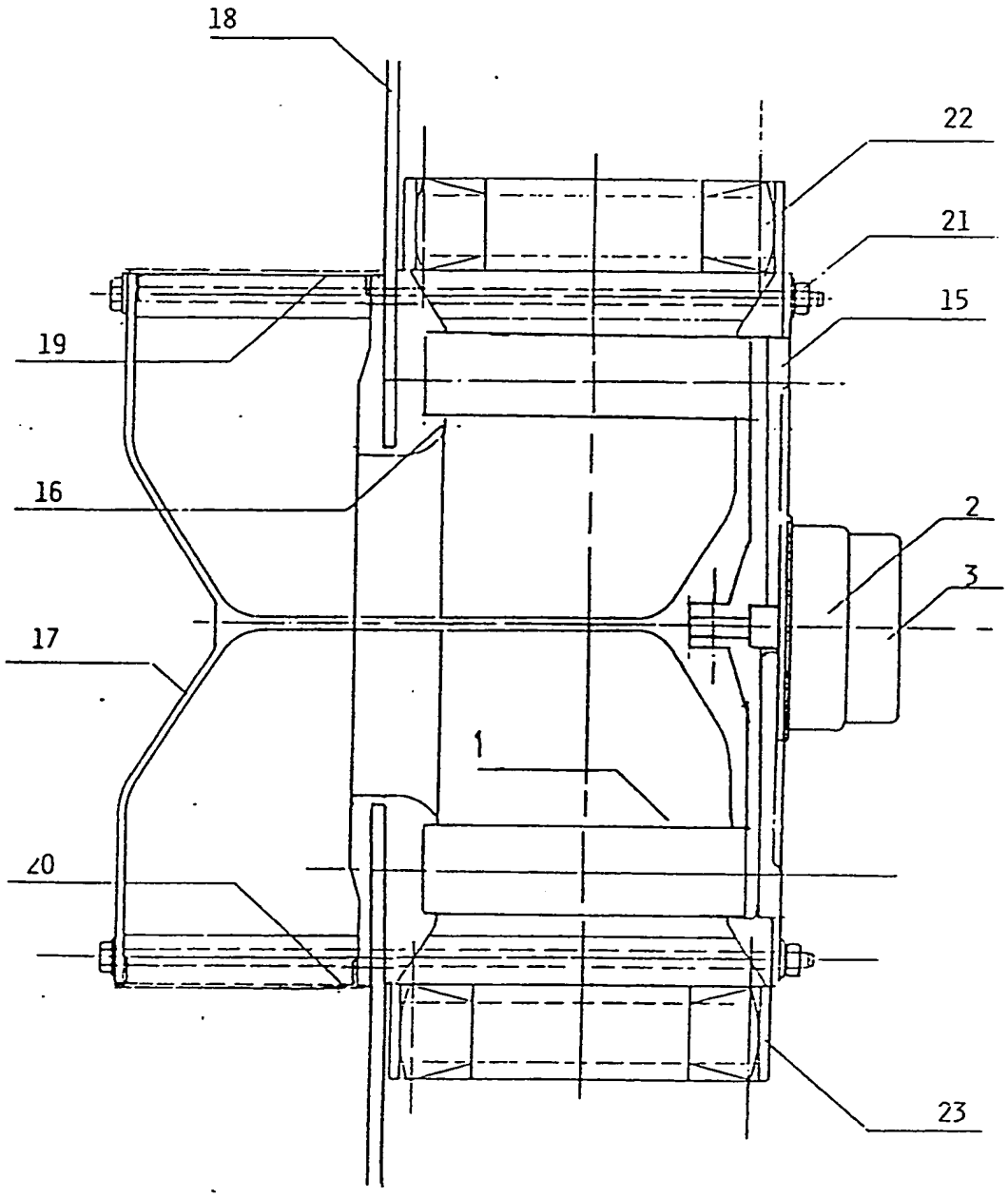


FIG. 3

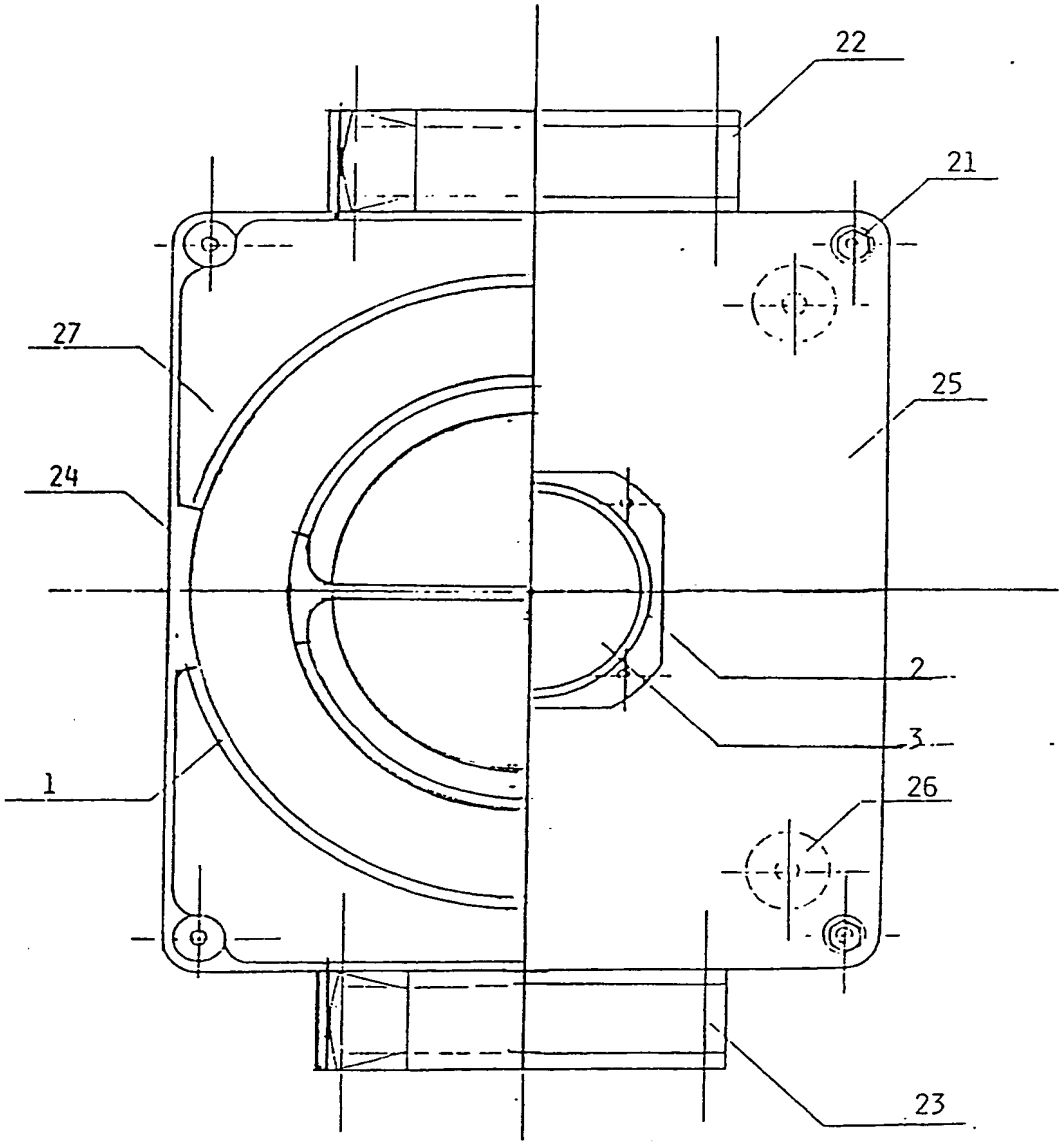


FIG. 4

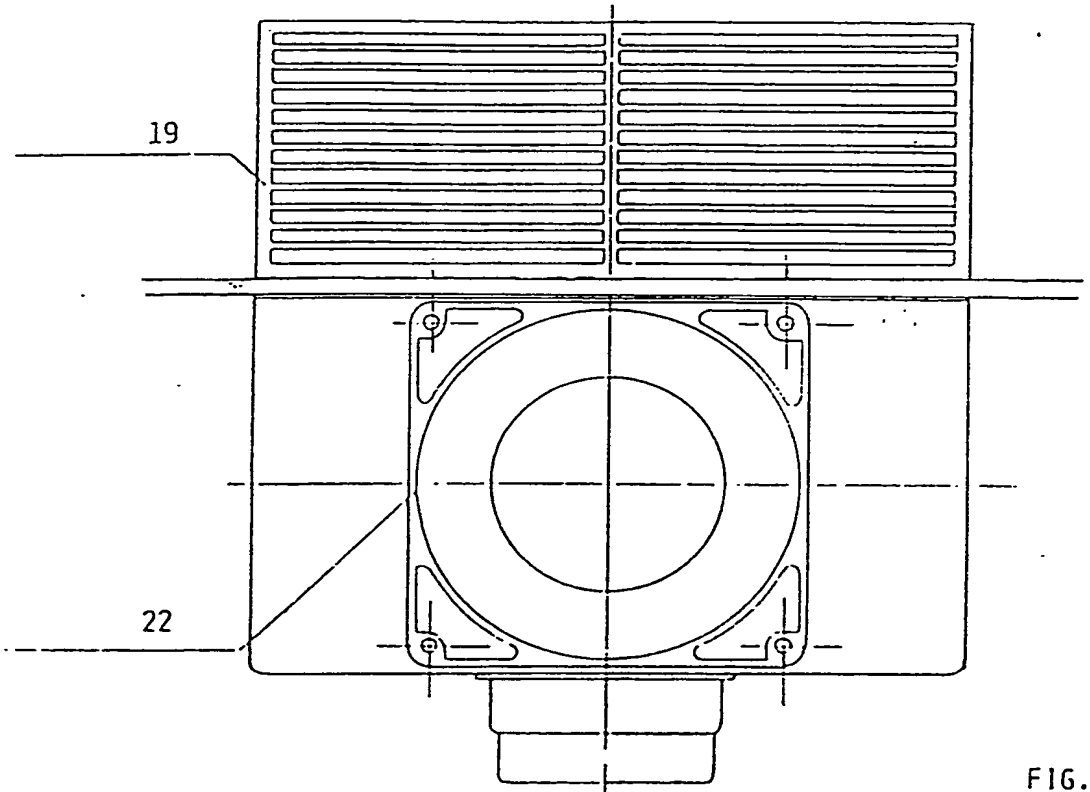


FIG. 5

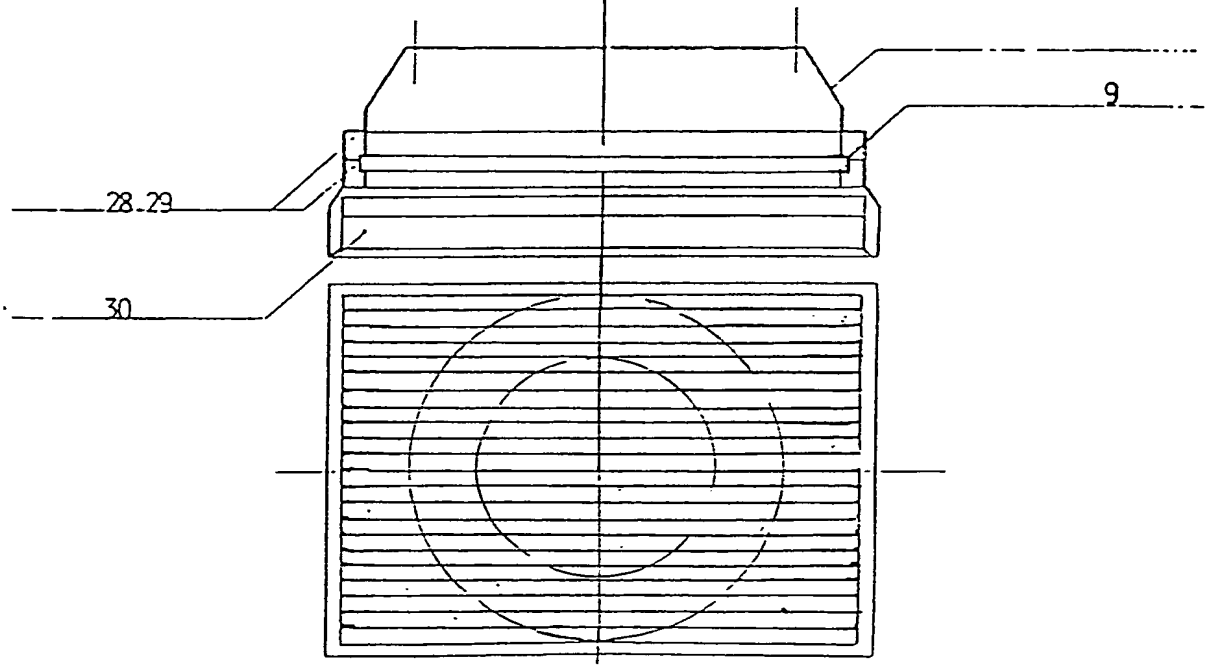
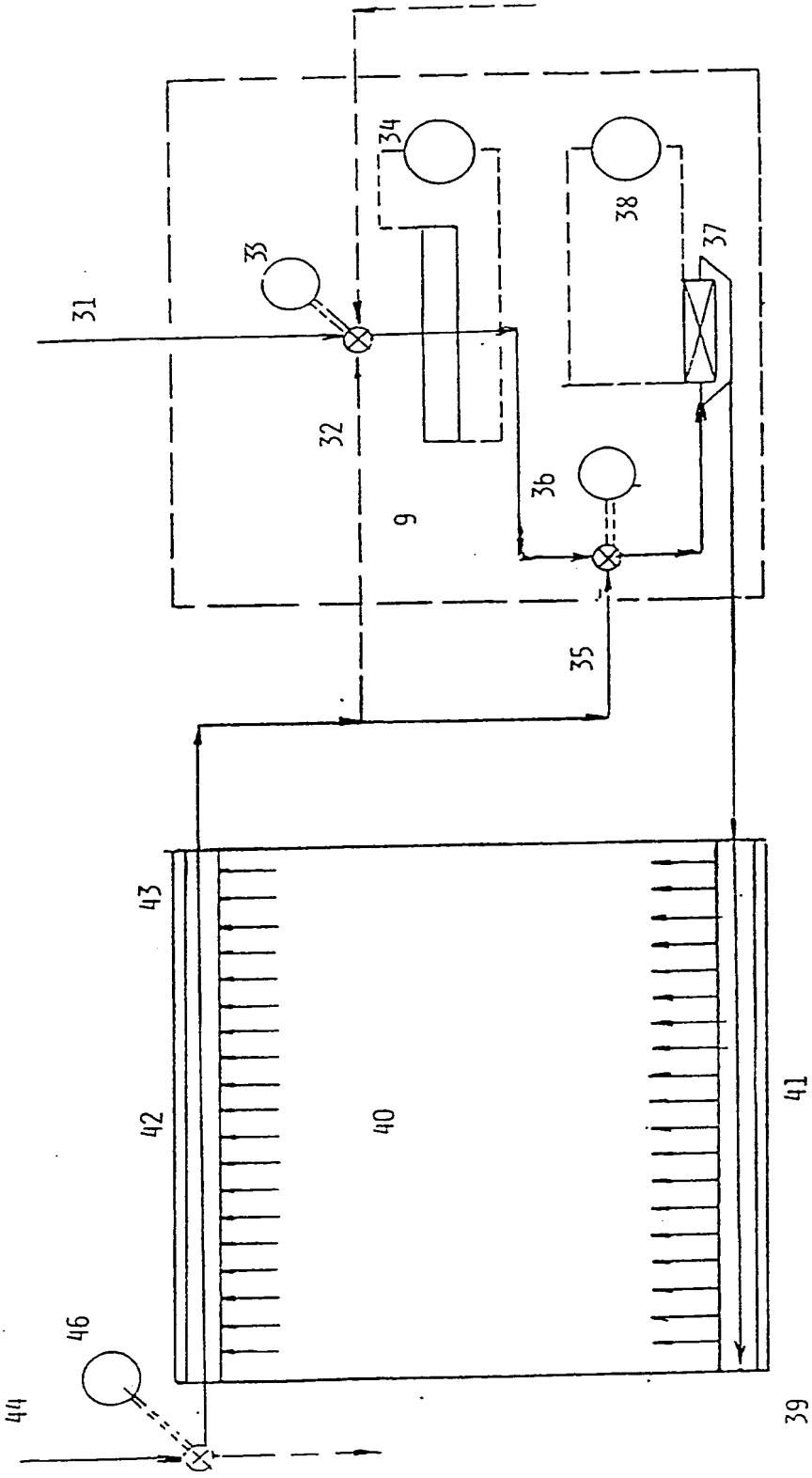


FIG. 5



An Electrically Operated Heating or Cooling Unit with Forced Ventilation Incorporating Waste Heat Recovery.

The invention relates to an electrically operated appliance which provides, apart from ventilation, i.e. replacement of stale by fresh air in a controlled manner, heating, and if required also cooling. This appliance can either serve an individual room or it can be used as a centrally operated unit, again with individual room service.

Fig.1 shows schematically the operational pattern as well as the components required to perform it. A regenerative heat exchanger with a matrix (heat exchanging part) shaped in the form of a drum rotates by means of a central drive consisting of a gear (2) and an electric motor (3). Other ways of rotating the drum can be used such as arranging a gear wheel at a convenient place of the outer periphery of the drum together with a pinion meshing with this wheel and an electric motor directly linked with it. Another way of driving the drum is to use a slow speed "linear" motion motor.

In the proximity of the drum a blower (4) with an integral motor (5) is arranged in such a way that the stale air extracted from the room (6) is passed through one half of the matrix (stale air side) before being exhausted to the atmosphere (7). Similarly an extractor (8) draws air from the atmosphere (7), passes this air firstly through the other side of the matrix (fresh air side) and then through an electric heater (9) before conveying the fresh air thus heated into the room (6). A by-pass valve (10) permits some of the stale air being conducted into the heated fresh air so as to reduce its temperature and increase its flow rate.

The extractor (8) is also driven by an integrated electric motor (11). Both electric motors, preferably DC operated have a speed control (12) and (13) respectively so as to adjust the performance of the blower and extractor respectively to operational requirements. The by-pass valve (10) can be regulated by a control device (14).

The matrix of the drum (1) consists of a multi-layer wound round wire gauze, the wire diameter being not more than half a millimetre and the (square) wire spacing between three to five times this diameter.

The stale air side and the fresh air side are separated by seals.

Wire type matrices have the additional advantage that their depth can be controlled by the wire diameter and the wire spacing, thus from a design point of view offering a choice of the size of the in and outflow area inside the drum.

Circumferential air exchange from the fresh air to the stale air side and vice versa due to the air contained in the matrix being rotated from one side to the other and the air exchange due to the area between the wires in the seals separating the two sides of the matrix when passing through are small when compared with the total air flow.

With contradirectional flow of the fresh and stale air in the matrix and with the wire dimension specified, together with the high temperature related efficiency realised on both sides of the matrix, the heat losses due to these flow exchanges are negligible as the

heat from the colder to the hotter face of the matrix through the wires (point contacts) is very low indeed.

Like the matrix of the drum, that of the heater consists of a high surface/volume ratio. This kind of matrix by the way can be similar to that of the drum permitting an operational surface temperature of only a few degrees higher than that of the fresh air when leaving the heater. This temperature can be governed by the fabric losses of the room as well as that - due to imperfect waste heat recovery - by the greatly reduced ventilation loss. However, the latter loss is very small indeed as the temperature related efficiencies in the matrix are 90% and more.

If the temperature of the heated fresh air is considered too high for safe distribution in the room, or if the flow rate is considered too low to achieve a high effectiveness of such distribution, dilution can be obtained by mixing the hot fresh air with a small amount of recirculated stale air, this amount being adjustable by a by-pass valve. Apart from regulating the blowers, such by-passing can also be used to maintain the balance between the weight flows of the incoming fresh and that of the outgoing stale air.

Another way of heating the fresh air in a similar way is to use a small high surface concentration matrix as mentioned before produced for instance from an electrically conducting ceramic material (say in the form of a foam) heating only a small amount of the fresh air to a very high temperature and mixing it with the rest of the (unheated) fresh air to the required temperature, thus the size of the heater matrix can be considerably reduced as can the space taken up by the heater. Again by-passing as mentioned above can be used to reduce this temperature further and at the same time increase the flow rate.

The fans are slim single stage axial units with the motor contained in the hub of the impeller. Efficient DC motors providing an easy way of speed regulation are preferred as the speed of the impeller can be chosen as high as necessary leading to an acceptable overall efficiency in a reasonable space. The stale air fan acts mainly as a blower, the fresh air fan mainly as an extractor, both fans are arranged in an axial position with regard to the drum and in close proximity to the side they serve.

The above characteristics are realised in an appliance as shown in the next three illustrations.

The wrapped round multi-layer wire gauze matrix (1) is fixed to a disc shaped carrier (15) the shaft of the geared motor is fixed to this carrier. The room side part of the casing (16) is shaped in such a way that it can accommodate the drum and provide the required degree of sealing between the two sides of the matrix. The inner part of the casing has also the task to divide the two sides in such a way that the flow of the stale air and that of the fresh air are properly separated.

The second part of the casing (17) is on the outside of the room separated for example by a window (18). This outer casing is furnished with a finger guard (19) on the stale air side (outflow of the stale air into the atmosphere); on the fresh air side a similar finger guard (20) is arranged together with a filter if required. The outflow area of the stale air and the inflow area of the fresh air are arranged in such a way that mixing of the two air streams is avoided.

The two casing parts, the inner and the outer can be joined together by ways and screws (21). The stale air blower (22) is an axial flow type, its DC motor being contained in the hub of the impeller carrying the blades. Again if required a finger guard can be attached to this motor which is arranged axially as far as the drum containing the matrix is concerned. The same is the case for the extractor (23) of the fresh air.

The arrangement of the seals is shown in Fig.3. Two seals (24) separating the stale air and the fresh air side are arranged symetrically. The circumferential length of the seals has a bearing on the amount of air exchanged between the two sides as already explained. This length should be about the same as the height of the matrix so as to prevent excessive flow exchange.

The motor is fixed to the front plate (25) in such a way that the front plate, the motor and the drum can be removed for inspection, cleaning of the matrix etc. The fan speed regulating devices such as potentiometers are also attached to this front plate. The space (27) between the faces of the fans and the part of the matrix they serve is such that a proper distribution of the air over the matrix is obtained without undue increase in space required for the unit.

Fig.5 illustrates the heater which can be either detachable or can be permanently fixed to the outlet of the fresh air extractor fan. This heater consists, apart from the matrix (9) of two insulating frames (28 and 29) also containing the contacts for the electric current. Furthermore in the same shell a finger guard (30) is included.

As far as the matrix (9) is concerned, its main characteristic is a high surface per volume ratio as obtained for instance by foam electricity conducting ceramic metal oxides or other similar structures formed for example by randomly packed gauzes, their wires being of a heat conducting, non oxidising material. The design principles to be applied to this kind of electric heater matrix combine the electric resistivity usually governed by operating temperature, the flow resistance causing a pressure drop when the air passes through the matrix, together with the heat transfer in such a way that the objective of a low surface temperature not much higher than that of the fresh air to be heated can be obtained. So, in contrast to other electric heater elements the matrix is characterised by a non glowing relatively low temperature operation.

A further possibility of applying the invention is shown in Fig.6. It concerns a central unit servicing all the rooms for example of a house by producing fresh air preheated by waste heat recovery from the stale air as already described and as a possible extra an electric heater of the kind described providing the base temperature for the different rooms.

Each of the rooms has an individual heating unit of the type described but without the heat exchanger. The fresh air from the central appliance enters the individual room unit, passes through a valve (32) regulated by a control device (33) and under normal operating conditions then passes through the matrix of the heater (9) again regulated by a device (34). The air thus heated after passing through a second valve (35) with a regulating device (36) enters a blower (37) driven by an electric motor and regulated by a device (38). The main function of this blower is to cater for the pressure losses of the circuit within the unit as well as those occurring in the room to be served, mainly in the distributor (39) to achieve a throw sufficient in intensity and distribution to provide the room (40) evenly with fresh air. This distributor is favourably near the floor (41) of the room.

Near the ceiling (42) a collector (43) attracts the spent stale air and passes it back to the central appliance (44) after flowing through a valve (45) regulated by a device (46).

The individual room heating unit if required (for example if the central appliance is being serviced) can operate independent of it. Either the stale air can be fed into the unit via a valve (32) or alternatively by using valves (45) and (32) fresh air can be introduced into the room. A periodical change from stale to fresh air can also be achieved with the control devices mentioned above.

Valve (35) is used for diluting the heated fresh air for example to reduce its temperature and increase its flow rate so as to improve the function of the distributor (41).

Therefore with a central unit in accordance with the invention, individual room units as described above, economical, versatile and healthy heating and ventilating can be achieved; important in view of present environmental trends, this including the need of regular air changes but also low energy consumption.

CLAIMS.

1. Electrically operated heating and cooling unit with forced ventilation incorporating waste heat recovery consisting of a drum type rotary regenerative heat exchanger, the drum driven by a geared electric DC motor, the area of the matrix, i.e. heat exchanging part incorporated in the drum and characterised by a high surface/volume ratio being sub-divided by diametrically opposed seals in two equal halves one for the flow of the stale air the other for that of the fresh air, the stale air being circulated by a fan driven by an electric DC motor this fan mainly working as a blower and the fresh air by a fan again driven by an electric DC motor mainly working as an extractor and an electric heater for further increasing the temperature of the fresh air after leaving the extractor characterised by a high surface/volume ratio as obtained for instance by foaming the electricity conducting material of the heater and a valve permitting the deflection of part of the stale air after leaving the blower into the fresh air after leaving the heater.

2. Unit as described under Claim 1 incorporating a matrix consisting of a multi-layer wire gauze wound round in the form of a cylinder, the diameter of the wires being not more than 0.5mm and the spacing of the wires about 3-5 times the wire diameter.

CLAIMS (contd.)

3. A drum incorporating the wire gauze cylinder consisting of an annular side wall on one end and a disc shaped side wall on the other whereby half of the circular area formed by the inner diameter of the annular side wall is used for the outflow of the stale air and the other half for the inflow of the fresh air and where the disc shaped side wall is linked with a gear motor centrally arranged driving through this side wall the matrix incorporated in the drum.

4. An outdoor casing consisting of parts for supporting the drum and the stationary parts of the seals together with the rest of the structure separating the flow of the stale air from that of the fresh air whereby the drum together with the side walls, the gear and the motor as well as part of the casing can be removed axially.

5. Axial flow fans with integrated electric motors being arranged axially to the drum and central to the area of the matrix they serve either with the flow of the stale or the flow of the fresh air whereby the distance between the face of the matrix and that of the fan adjacent to it is such that a low loss homogenous distribution of the air facilitated by a high flow resistance of the matrix can be achieved.

CLAIMS (contd)

6. Unit as described under Claims 1-5 being augmented by an electric heater attached to the outlet of the fresh air fan consisting of a casing in which a matrix type of heater element, for example a high surface/volume foam made from a heat conducting material such as metal oxides is held by two frames of insulating materials and where a finger guard is arranged near the outlet of the heater.

7. A heater matrix in accordance with the above, the dimensions between the temperature of the surface of the matrix and that of the fresh air after being heated is only a few degrees.

8. A unit in accordance with the above claims having a by-pass duct controlled by a valve between the outlet of the stale air fan and that of the heater so that by setting the valve both the flow rate as well as the temperature of the fresh air can be controlled.

9. A unit in accordance with the above claims having an outdoor casing fore the egress of the stale air and the ingress of the fresh air, the two flow areas being arranged in such a way that the stale air and the fresh air flow in opposite directions preventing mixing of both.

10. An outdoor casing in accordance with the above where the in and outflow areas are protected by a grid and where in addition the incoming fresh air is filtered in accordance with needs.

CLAIMS (contd)

11. A unit in accordance to the above where the indoor and outdoor casings, separated by a window or wall are joined by bolts.

12. A unit in accordance with the above claims having a heating as well as cooling capability by adding a device which works in accordance with the known Peltier principle.

13. A unit in accordance with the above claims where the speed of the two fans, the electrical input to the heater and cooler and the by-pass valve can be controlled by known methods.

14. A unit in accordance with the above claims serving as a central appliance all rooms of a house whereby each of the rooms has an augmenting unit incorporating an electric heater and cooler as well as an additional blower mainly catering for the pressure drops within the unit as well as that of the distributor near the floor with a throw sufficient to effectively ventilate the space between the distributor and the collector near the ceiling.

15. An augmenting unit as claimed above including a valve (35) which permits recirculating part of the stale air as an additional control of the temperature as well as flow rate of the fresh air.

CLAIMS (contd)

16. An augmenting unit as claimed above incorporating a further valve (32) which by closing the valve (46) allows recirculation of the stale air in the case where the central appliance is out of action.

17. A unit as claimed above where fresh air enters the valve (32) and leaves as stale air through the open valve (46) at the outlet of the collector in the case where the central appliance is out of action.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

9015686.0

Relevant Technical fields

(i) UK Cl (Edition K) F4V, VFAAB, VFAX, VFAX, VGBW

(ii) Int Cl (Edition 5) F24F

Search Examiner

R W BALDOCK

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES CLAIMS, WPI

Date of Search

11 DECEMBER 1991

Documents considered relevant following a search in respect of claims 1, 2, 6, 8-17

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
Y	GB 2203824 A (HRYINISZAK) SEE ESPECIALLY PAGE 7 LINES 1-6 ROTOR DRIVEN BY GEARED ELECTRIC MOTOR	1, 9-11, 13, 16
Y	GB 2164135 A (HRYNISZAK) SEE ESPECIALLY PAGE 1 LINES 33-37 - BLOWERS DRIVEN BY ELECTRIC MOTORS	1, 9-11, 13, 16
X	GB 1232432 (MUNTERS) SEE ESPECIALLY PAGE 3 LINES 21-65 SEALING BETWEEN THE 2 ZONES; ROTOR TURNED BY GEARED MOTOR	1, 9-11, 13, 16
Y	GB 808412 (MUNTERS) SEE ESPECIALLY PAGE 2 LINES 52-54, 93-99, SEALING	1, 9-11, 13, 16
X	US 4596284 (LTG) SEE ESPECIALLY COLUMN 5 LINES 26-32, ROTOR TURNED BY ELECTRIC MOTOR, LINES 53-62 STALE AND FRESH AIR FANS DRIVEN BY ELECTRIC MOTORS, COLUMN 3 LINES 58-64 INTAKE AIR SUCKED IN, EXHAUST AIR BLOWN OUT	1, 9-11
Y	GB 2226126 A (CARRIER) SEE ESPECIALLY PAGE 1 LINES 14-16 MIXING OF FRESH AND STALE AIR	1

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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